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Published in:
GSTF International Journal of Law and Social Sciences

DOI 10.7603/s40741-014-0002-5

GSTF International Journal of Law and Social Sciences (JLSS) Vol.3 No.2, April 2014

The Persuasive Powers of DNA: An Experimental Study in Perceptions of Expert Evidence

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Received 27 Dec 2013 Accepted 10 Mar 2014

Abstract—**This article presents the results of an experimental study where mock-jurors were tasked with interpreting the presentation of DNA evidence. The 200 university student participants were exposed to one of five murder scenarios where the information about the DNA evidence was manipulated. The results showed that participants were more likely to convict when the DNA match statistic was presented as a probability (0.1%) and focused on the defendant, less likely to convict when it was presented as a frequency (1 in 1,000) and focused on a broader reference group, and even less likely in the control scenario with no DNA evidence. The forensic knowledge of participants was also explored, and more than three-quarters demonstrated reasonable understanding of the individuating capacity of DNA evidence. Participants recognized that while DNA has the capacity to determine guilt, it is insufficient on its own to convict or acquit. The implications for the presentation of expert testimony and judicial instruction are canvassed, and the broader ramifications for the education of jurors and legal personnel are discussed.**

Index Terms—DNA evidence, expert evidence, juror decision-making, match statistics

I. INTRODUCTION

HE forensic application of DNA has increased the frequency Tof criminal investigations that rely on biological material for identification purposes (Goodman-Delahunty & Tait, 2006) and this impact clearly carries through into the adjudicative setting (Amorim, 2012; Briody, 2003; 2004). Due to its use in violent and high profile cases, and its role in overturning wrongful convictions, DNA analysis has been considered the great panacea for criminal investigations and court proceedings (Butler, 2001; Cooper, 2012; Kirby, 2010; Lincoln & Wilson, 2005; Lynch, 2013). It was once characterized in a US court as "the single greatest advance in the search for the truth, and the goal of convicting the guilty and acquitting the innocent, since the advent of cross-examination" (*New York v Wesley*, 533 N.Y.S. 2d 643, 644, S. Ct. 1988), and still garners such laudatory sentiments.

It is, of course, difficult to argue against the power of DNA to incriminate the guilty, or deny its crucial role in exculpating the innocent, but like all powerful tools it has the capacity to produce undesirable consequences (Edmond, 2011; Goodman-Delahunty & Tait, 2006; Kirby, 2010; Langdon & Wilson, 2005; Lynch, 2013; McCartney, 2006). In the wake of the claim last century that little is known "about how laypersons respond to DNA evidence" (National Research Council, 1996), the body of research in this area has expanded significantly, providing knowledge about the weight that legal decision makers assign to it in forensic settings (Briody, 2003; 2004; Goodman-Delahunty & Hewson, 2010; Goodman-Delahunty & Wakabayashi, 2012; Findlay, 2008; Koehler, 2001; Koehler & Macchi, 2004; Kruse, 2012; Lynch, 2013; Smith & Bull, 2012; Smith, et. al., 2011; Wheate, 2006; 2010).

Studies in Australia demonstrate that there is potential to overly rely on DNA (Briody, 2003; 2004). In one jurisdiction, it was found that cases of murder and sexual assault that include DNA have a higher likelihood of going to trial and a higher likelihood of securing a conviction than do cases without this type of evidence (Briody, 2003; 2004). Such empirical studies raise serious questions about how jury members interpret individuating DNA evidence in court. Some research on juror comprehension has shown that jury members view DNA evidence as very important in determining guilt (Findlay, 2008). Indeed they claim it to be of greater significance in their deliberations than any other type of evidence (Findlay, 2008; Wheate, 2010). This extends to the view that jurors are "completely intractable and unwilling to even consider a conviction" without its presence (Wheate, 2010, p. 135).

The manner in which DNA evidence is presented at trial can have a considerable impact on the way it is interpreted by jurors (Koehler, 2001). It has been found that when a DNA statistic is framed as a probability (.001) that targets a specific suspect (the likelihood that the accused is the source), it is more persuasive to a jury than when it is presented as a frequency (one in one

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DOI: 10.5176/2251-2853_3.2.153

Published online: 30 May 2014

thousand) and targets a broad reference group (the people of a local area). A number of studies have yielded similar findings about the interpretation of probabilities and frequencies (Koehler, 2013; Konheim-Kalkstein, et. al., 2009; Schklar & Diamond, 1999; Slovic, et. al., 2000; Tversky & Kahneman, 1973). The persuasive power of DNA evidence versus the interpretation of the various presentation methods raise important issues about how it can best be delivered to juries.

The current study seeks to update and build upon the works of Koehler (2001) and Briody (2003; 2004) by addressing three major issues. First it explores whether mock-jurors are more inclined to return a guilty verdict in cases involving DNA evidence. Secondly, it compares whether mock-jurors assign more value to DNA statistics when they are presented as probabilities rather than frequencies, with attention paid to reference groups. Finally, the study examines the influence that background knowledge has on juror assessments of guilt. Other research has addressed knowledge about forensic DNA among laypersons in relation to improving this knowledge (Goodman-Delahunty & Hewson, 2010). However, no existing works have matched participants' understandings of DNA evidence with the presentation format in which it is delivered and how this subsequently impacts on mock-trial verdicts.

II. Overview of the Literature

Given the increasingly common usage of forensic DNA evidence in criminal investigations and trials, it is unsurprising to find a rapidly expanding body of empirical research and crimino-legal commentary on this topic (Cooper, 2012; Haesler & van Daal, 2011; Kirby, 2010; Lynch, 2013). Recent studies have focused on how forensic DNA evidence is perceived and understood by jurors and legal personnel (Smith, et. al., 2011; Smith & Bull, 2012; Dartnall & Goodman-Delahunty, 2006; Findlay, 2008; Goodman-Delahunty & Hewson, 2010; Wheate, 2010). While there seem to be inaccurate understandings about DNA by jurors (Briody, 2003; 2004; Dartnall & Goodman-Delahunty, 2006; Findlay, 2008; Schklar & Diamond, 1999; Wheate, 2010), the reasons for this have yet to be confirmed.

One contributing factor is how this type of forensic evidence is presented to jurors in the courtroom. Several studies suggest that the manner in which forensic DNA experts deliver their findings strongly affects the perceptions by triers of fact (Aarli, 2012; Amorim, 2012; Bornstein, 2004; de Keijser & Elffers, 2012; Edmond, 2011; Goodman-Delahunty & Wakabayashi, 2012; Henderson, 2002; Koehler, 2013; Konheim-Kalkstein, et. al., 2009; Kruse, 2012; Ligertwood, 2011; Noordgaard & Rasmusson, 2012; Redmayne, 2001). Differences in explanations of probabilities and statistics, as well as the use of advanced terminology, appear to add to the confusion experienced by jurors. In addition, this lack of understanding extends to legal personnel — judges, prosecutors and defense counsel (Cooper, 2012; Henderson, 2002; Kirby, 2010; Selby, 2010). Thus the following brief review of the literature focuses on two key streams: the perceptions that abound in courtrooms about forensic identification evidence; and the manner in which forensic experts present their findings at trial.

A. Perceptions of Forensic DNA Evidence

Research suggests that the lack of understanding by jurors regarding how DNA evidence works and the relevance of statistical analyses lead to an unquestioning acceptance of the reliability of DNA. A variety of psychologically-focused studies and legal commentaries describe this phenomenon and assess its impact for potential miscarriages of justice (see Amorim, 2012; Cooper, 2012; de Keijser & Elffers, 2012; Edmond, 2011; Findlay, 2008; Henderson, 2002; Kirby, 2010; Koehler, 2013; Konheim-Kalkstein, et. al., 2009; Kruse, 2012; Ligertwood, 2011; Lynch, 2013; Noordgaard & Rasmusson, 2012; Redmayne, 2001; Selby, 2010; Wheate, 2010). For example, in one study jurors claimed that DNA evidence was very important as "inculpatory" evidence, but admitted that they lacked understanding about DNA processes, error rates, and the like (Findlay, 2008).

Work by other authors continues to establish this theme of poor knowledge about forensic DNA evidence by jury members (Dartnall & Goodman-Delahunty, 2006; Goodman-Delahunty & Hewson, 2010; Goodman-Delahunty & Tait, 2006; Henderson, 2002; Wheate, 2006). In one research project about improving juror assessments of statistical DNA evidence, participants displayed low levels of awareness about this evidence type during pre-trial surveys with only a quarter of questions being answered correctly (Goodman-Delahunty & Hewson, 2010). However, the presence of DNA evidence in a criminal case increased the number of guilty verdicts in mock-trial scenarios despite this lack of knowledge (Goodman-Delahunty & Hewson, 2010). As a result there is a "near impossibility of getting rational people to think that scientific (especially DNA) evidence may be inaccurate, inadequate or contaminated" (Kirby, 2010, p. 28).

In addition, the pre-eminence of DNA evidence, partly due to its capacity for individuation and its strong probative value (Ligertwood, 2011), remains an issue. For example, jurors participating in mock trial research tended to fixate on DNA evidence, reporting a belief that it was more "important" than other evidence types (Wheate, 2010). In evidentiary terms, it is seen as more "factual", infallible and unsusceptible to error than other evidence types such as eyewitness accounts (Cooper, 2012; Lynch, 2013). Further, where DNA evidence was absent, participants were less likely to offer guilty verdicts with the observation that without DNA evidence "some jurors would never say 'guilty'. They just wanted DNA evidence and wouldn't accept anything less" (Wheate, 2010, p. 135). This finding was reflected in a study of Australian and Canadian jurors where the lack of forensic DNA evidence provoked questioning from participants about its absence (Holmgren & Fordham, 2011).

The unquestioning acceptance of DNA evidence expands beyond jurors to legal personnel such as judges, prosecutors and defense counsel. There are many cases where prosecution and defense have misunderstood the significance of forensic evidence provided by expert witnesses, and there are claims that "there is a very real danger" of DNA "being abused through widespread misunderstanding of the statistical basis of its results" (Henderson, 2002, p. 186).

In contrast, there are findings indicating that jurors can engage with many forms of evidence and are able to evaluate DNA in

the context of a given case (Goodman-Delahunty & Hewson, 2010; Holmgren & Fordham, 2011; Smith, et. al., 2011). It has also been found that while the absence of DNA was an issue for some jurors, this did not prevent them from carefully considering and weighing other types of evidence in their deliberations (Holmgren & Fordham, 2011). A significant perspective was that jurors "look to see what other aspects of the evidence supported or contradicted [expert DNA evidence] and assess evidence on that basis" (Holmgren & Fordham, 2011, p. 70). So, jurors do not necessarily accept DNA at face value and are able to assess it in conjunction with other evidence types when deliberating (Findlay, 2008; Goodman-Delahunty & Hewson, 2010; Goodman-Delahunty & Wakabayashi, 2012; Holmgren & Fordham, 2011; Kruse, 2012).

However, this picture is even more complicated because with the increasing inclusion of DNA in criminal trials there has been a concomitant decrease in caution by laypersons in evaluating this type of evidence (Haesler & van Daal, 2011). There is a further muddying of the findings because pre-trial biases in favor of the prosecution can encourage greater probative value being placed on even very weak forensic evidence (Smith & Bull, 2012). And, the manner in which DNA is described is important for how jurors evaluate it. Studies have identified that jurors use pieces of evidence to formulate a "story" of the case in their heads; they tend to be more convinced by the same evidence when provided anecdotally and in reference to specific cases than when provided in more abstract terms (Bornstein, 2004; Kruse, 2012).

This indicates that the persuasiveness of a lawyer or scientific expert in their explanation of the DNA evidence can impact on juror perceptions. Recent findings also suggest that the increasing trend for criminal trial proceedings to utilize only a single forensic expert may discourage the proper consideration of DNA evidence during juror deliberation processes (Goodman-Delahunty & Wakabayashi, 2012). The mock trial study revealed that the presence of separate forensic experts for the defense and the prosecution led to stronger engagement with forensic testimonial material and a perception of prosecution experts as being less persuading than when no expert testified for the defense (Goodman-Delahunty & Wakabayashi, 2012).

B. Presentation of DNA in the Courtroom

The basic science of DNA and its testing is now less in question but the manner in which the evidence is presented remains under scrutiny (Cooper, 2012; de Keijser & Elffers, 2012; Koehler, 2013; Ligertwood, 2011; Nordgaard & Rasmusson, 2012). The probative value of a DNA match is expressed using statistics, ultimately describing certain traits of the profile and how common they are in a given population (Koehler, 2013; National Academy of Sciences, 2009). Probability-style presentation of DNA is the most frequently adopted method in the courtroom. The two most universally accepted means of presenting probabilistic DNA evidence are random match probabilities (RMP) and likelihood ratios (LR) (Amorim, 2012; Koehler, 2013; Noordgaard & Rasmusson, 2012).

Likelihood ratios are used when there is more than one conflicting hypothesis about a piece of DNA evidence (e.g. who left a sample at a crime scene); it constitutes a method which allows experts to determine how much more or less the evidence supports one theory over another (Koehler, 2013; Noordgaard & Rasmusson, 2012). The final statistic provided in an LR is therefore not a probability in itself, but a ratio of probabilities; it "is not a property of the examined individual [but] just translates the relative likelihoods of an event — the evidence — when explained by two alternative, exhaustive, mutually exclusive hypotheses" (Amorim, 2012, p. 264). By comparison, RMPs describe the frequency of a DNA profile within a given population (Koehler, 2013). A smaller RMP is of greater probative value than a larger RMP due to the fact that the former indicates a lesser chance that a DNA match is coincidental (Koehler, 2013).

Both these methods of presenting DNA evidence have associated drawbacks. Primarily, the difficulty lies in that those likely to be empanelled on a jury generally have poor statistical reasoning abilities (de Keijser & Elffers, 2012; Findlay, 2008; Goodman, 1993; Koehler, 2013; Koehler & Macchi, 2004; Ligertwood, 2011; Wheate, 2006). Therefore, when jurors are required to review DNA evidence that is explained using statistical analyses, it is not clear how such evidence is appraised. People often commit errors of reasoning when dealing with probabilistic information, and this can result in a misinterpretation of DNA evidence findings (Koehler, 2013). For example, "if one infers, from an extremely small RMP, that the matchee is the source of the evidence, this inference should not prompt the additional inference that the matchee must have committed the crime in question" (Koehler, 2013, p. 532). However, both jurors and legal professionals fall prey to this error in statistical reasoning (de Keijser & Elffers, 2012; Edmond, 2011; Selby, 2010).

Lawyers have been found to compound the issue through commission of the prosecutor's fallacy, particularly when the RMP is very small (Koehler, 2013; Selby, 2010). It is for this reason that some argue against the use of RMPs, suggesting that they may be harmful, rather than helpful, when dealing with DNA evidence (Aarli, 2012; Koehler, 2013). Unfortunately, LRs also suffer the same drawbacks, with research indicating that jurors and lawyers have poor comprehension of this type of statistical information. For example, it has recently been found that proper understandings of LR and related statistical concepts were poor among jurors and legal personnel, and that many lawyers appeared to commit the prosecutor's fallacy when dealing with such evidence (de Keijser & Elffers, 2012). Similarly, it is noted that while LR may be a less misleading statistical concept than RMP, there is no indication that jurors or lawyers have a more sound understanding of this method (Amorim, 2012; Noordgaard & Rasmusson, 2012).

The flaws inherent in probabilistic presentation of statistical DNA evidence have led some authors to recommend the use of frequency-style approaches to communicating effectively about this evidence to juries and legal personnel. Frequency presentation methods are argued to align more closely to the human inductive approach to reasoning than probabilistic methods (Ligertwood, 2011). To explain forensic DNA matches to juries using a frequency format may encourage jurors to consider how many people within the suspect pool might have matching DNA; this is vital when considering that all other potential suspects must be excluded before

determining a defendant's guilt or innocence (Ligertwood, 2011; Redmayne, 2001). Recent findings continue to support this perspective, with empirical data indicating that jurors tend to have poorer reasoning when dealing with probabilistic information than with statistical frequencies (Koehler, 2013). However, frequency-formatted methods of expressing DNA statistics have been found to be less convincing in court than probabilistic methods (Konheim-Kalkstein, et. al., 2009).

III. Method

The debate about which of the two approaches is more suited to the accurate and effective communication of forensic DNA evidence to criminal courts continues, and the present study aims to contribute to this discussion. This study adopts an experimental approach via manipulations of case study information, specifically the format in which DNA evidence is presented, or not, to a sample of mock-jurors. The study replicates and extends the work of Koehler (2001) by utilizing a modified version of his case study of a fatal armed robbery (Koehler & Macchi, 2004). The study also takes up the findings from the Australian studies (Briody, 2003; 2004) in that the design includes a control group for which no specific DNA evidence is included in one of the case scenarios. Further, the earlier research is extended by the inclusion of questions designed to extract additional information about decision-making by the mock-jurors.

A. Participants

The sample comprised 200 undergraduate and postgraduate university students enrolled in criminology, psychology and communications studies. The data show that the majority of participants (60%) did not have a background in a justice/legal discipline. Almost all participants (98%) stated that they had not served on a jury. There were 129 females (65%) and 69 males (35%) across three main age categories: 18 to 21 years (62%), 22 to 30 years (31%), and 31 to 55 years (7%), with an average age of 31 years, and a majority who were Australian-born (56%).

B. Procedure

The different scenarios and the ways in which the DNA evidence was presented are complex (see Figure 1). First, there are "single-targets" which focus on a specific individual or event, and "multi-targets" which focus on groupings of individuals or events (Koehler & Macchi, 2004). In addition there are two manipulations of the framing of the DNA statistic, either as a "probability" (expressed as 0.1%) or a "frequency" (expressed as 1 in 1,000). This yields four possible "target/frame" formats. The fifth condition is the control group in which only circumstantial evidence (e.g. weapon details and alibi information) are presented.

The "single-target" segment offers a small reference group by focusing exclusively on the suspect. Similarly, the "probability frame" promotes a "narrow, 'inside' view in which instant cases are contemplated in isolation" (Koehler, 2001), thus, encouraging participants to only consider this defendant's case without reference to related persons or cases. Therefore in Scenario 1, for example, the combination (single + probability) limits the likelihood that a juror will consider someone else's guilt and thereby increases the likelihood of a guilty verdict being returned. By comparison is Scenario 4 that used a "multi-target" element that encourages the reference of other persons and cases by focusing on the grouping of individuals or events. When the statistic was framed as a "frequency" the likelihood is that this allows jurors to identify others who might match the DNA evidence (Koehler, 2001; Slovic, et. al., 2000; Yamagishi, 1997).

Scenario	Target/Frame Combination	Example
1	single-target probability frame	*The probability that the suspect would match the blood drops if he were not their source is 0.1%*
2	single-target frequency frame	*The frequency with which the suspect would match the blood drops if he were not their source is 1 in 1,000*
3	multi-target probability frame	*0.1% of the people in the [local area] would also match the blood drops*
4	multi-target frequency frame	*1 in 1,000 people in the [local area] would also match the blood drops*
5	no DNA evidence	*Eyewitness identification, physical evidence and limited alibi only*

Figure 1: Target and frame formats across the five study conditions.

It was hypothesized that Scenario 1 would yield more guilty verdicts; that Scenario 4 would yield more not-guilty verdicts; that Scenarios 2 and 3 would probably be conflated and therefore participants' responses would be mixed; and that the mock-jurors in the four experimental conditions would be inclined to return a guilty verdict compared with those in the control group.

The instrument (a three-page questionnaire) contained brief details of a murder that took place during an attempted armed robbery set in the local area (cf Koehler, 2001). The remainder of the instrument included questions targeted towards the defendant's involvement in the crime and participants were asked to provide a verdict and an explanation as to how they arrived at that verdict. For the qualitative data, three independent raters were tasked to engage in post-hoc analyses. From this it was determined that there were nine categories justifying not-guilty verdicts, and five categories justifying guilty verdicts. These questions serve to operationalize whether there is a relationship between the persuasiveness of DNA evidence and the formats in which they are presented.

There were also questions aimed to measure participants' knowledge of DNA evidence and its capabilities. Included was a question intended to determine, based on a given population and DNA match statistic, if participants were able to ascertain the number of people who were not the source of evidence but would still provide a DNA match with the recovered blood evidence. The instruments were distributed via random allocation to volunteer participants in university classroom settings.

IV. Results

Despite the larger proportion of female participants there were no overall differences between the sexes on responses to the major questions (verdict, views on DNA, knowledge, etc), even though females were disproportionately (albeit randomly) assigned to the experimental conditions of Scenarios 3 and 4. Similarly, with age there appeared to be no bias in responses because of the age distributions across the various groups. The only exception was where those who nominated a guilty verdict and were in the youngest age group (18 to 21) opted for reasons other than the DNA evidence. And, it should be emphasized here that the research hypotheses were not focused on age or gender factors.

A not-guilty verdict was given by almost three-quarters of the sample. Of the 145 participants who gave a not-guilty verdict 31% stated it was because there was "no corroborating evidence". For example, one open-ended response coded in this category was: "while DNA evidence is a significant aspect of any criminal investigation, it cannot be relied upon by itself to prove guilt beyond a reasonable doubt". An additional 21% of participants who provided a not-guilty verdict stated that the evidence of the expert witness was not strong enough. As for guilty verdicts, 35% of this group claimed the "blood match evidence" to be the basis of their decision, and as one participant wrote: "I believe the blood DNA evidence to be very reliable and the chances of the DNA evidence being wrong is less than the chance of an eyewitness being wrong". Other participants in this category focused on the expert testimony stating there was "strong statistical evidence provided by the expert witness". Of note is that across all groups DNA was deemed to have a low error rate where 51% of all participants responded that there would be fewer than 2 errors in 100 DNA match analyses.

The next set of results applies only to the experimental groups (n=160). The first question required participants to provide the probability (as a percent) for which they believed the suspect to be the source of the blood evidence p(source), which yielded a modal response of 99.9%. Participants in the experimental conditions were also asked to provide the probability in which they believed the suspect committed the crime — p(guilt). The most frequent estimates were 50 (31%) or 90 (13%) percent. When participants were asked to extrapolate the likely matches to people in the local area 40% of those who answered this question produced a correct answer. The cross-tabulation revealed that answers to Scenario 1 were significantly different to those of Scenarios 2, 3 and 4 (p=.000) which contained more than four times the number of correct answers as did Scenario 1.

The experimental groups responded to a series of question aimed to measure their knowledge about DNA evidence and its capabilities. The first three questions specifically addressed the individuating capacity of DNA: 78% agreed that a DNA analysis could reveal a person's gender; 80% affirmed that blood relatives have similar DNA structures; whereas 75% responded that identical twins did not share the same DNA profile. Further when asked if a DNA profile was obtainable from a urine sample: 53% disagreed; 85% agreed that blood, saliva and semen samples taken from the same person would give the same DNA profile; whereas 52% affirmed that human hair without the root could be analyzed for DNA. These results suggest that the majority of participants possess reasonable knowledge of DNA and its capabilities.

The findings relating to participants' confidence in DNA evidence were: 54% of the sample agreed that DNA evidence can tell if a person is innocent or guilty; and 76% disagreed that DNA evidence alone was enough to acquit or convict a person. For the questions that were only asked of the control group (n=40), participants were asked whether or not the case should have gone to trial with 58% concurring. If participants responded no they were asked to provide other forms of evidence that would have made the case more suitable for adjudication. Here they provided multiple responses, with the majority being video surveillance and DNA evidence, and minority responses of fingerprint, multiple witnesses and medical evidence.

The guilty verdicts across the experimental groups were Scenario 1 (62%), Scenario 2 (68%), Scenario 3 (62%) and Scenario 4 (85%). However, as hypothesized, the results showed that participants' estimates of p(source) — probability of the suspect being the source of the blood evidence, and p(guilt) — probability that the suspect was guilty of the murder, varied according to target and frame format. A greater proportion of participants in the "single-target-probability frame" condition responded with higher estimates of p(source) and p(guilt) — 74% and 68% respectively — than did jurors in the "multi-target frequency frame" condition — 46% and 48% respectively.

In addition, results for p(source) were recoded into two categories: 0 to 98% and 99 to 100% to reflect the distributions of responses, and it showed that the proportion significantly decreased in the Scenario 4 "multi-target frequency-frame" format (p=.002). As illustrated in Table 1, a cross-tabulation of the recoded data and the four experimental conditions demonstrated that the proportions of subjects who were 99% certain that the suspect was the source of the blood evidence in the recoded data were 42%, 22% and 35% in Scenarios 1, 2 and 3 versus 8% in Scenario 4.

Scenario	*p*(source)=<=99%	*p*(source)=>=99%
Single-target		
Probability frame (scenario 1)	58	42
Frequency frame (scenario 2)	78	22
Multi-target		
Probability frame (scenario 3)	65	35
Frequency frame (scenario 4)	92	8

Table 1: Probability of being the source of blood evidence, more or equal to 99% by scenario (n=160).

It was hypothesized that Scenarios 2 and 3 would conflate and the verdicts returned under these conditions would cluster in the middle of the more extreme scenarios but this did not occur. Rather, the distribution of verdicts in Scenarios 2 and 3 resemble those of Scenario 1, with guilty results comprising 38%, 32%, 38% and 15% respectively across all four scenarios. These results support one of the main hypotheses in that significantly more participants returned a guilty verdict in cases involving DNA evidence (p=.048). When given the case

without DNA (Scenario 5) 85% of participants returned not-guilty verdicts compared to only 70% of participants returning not-guilty verdicts in the four experimental scenarios with DNA evidence.

V. Conclusions

Probability estimates provided by mock-jurors confirmed that when presented with "single-target probability frame" the mean estimate that the suspect was the source of the blood evidence was higher than when presented with the "multi-target frequency-frame". Likewise, participants' verdicts demonstrated that fewer jurors in the first condition returned a not-guilty verdict than did those in the latter. These results concur with recommendations by Ligertwood (2011, p. 487) that a frequency presentation "that emphasizes the possibilities of an innocent explanation" is essential.

An explanation can be found in "exemplar cueing theory" and the "availability heuristic". Exemplar cueing theory suggests that people judge the probative value of a match according to the ease in which they can imagine others who also fit the match (Koehler, 2001), and the availability heuristic holds that people make judgments concerning the probability or frequency of an event based on their knowledge of similar past events (Tversky & Kahneman, 1973). Thus, jurors who were given limited reference to other scenarios by focusing on the suspect were more inclined to return guilty verdicts. On the other hand, jurors who were given a large reference group by inferring the potential culpability of others were more inclined to return not-guilty verdicts.

The surprising finding was that Scenarios 2 and 3 which contained one segment that encouraged the reference of other persons and events and the other element that discouraged the reference of other persons and events still tended to infer guilt. A central focus of this study suggested that more jurors would return a guilty verdict in cases involving DNA evidence and the analysis indeed revealed that twice the proportion of participants presented with DNA evidence returned guilty verdicts (see Briody, 2003; 2004).

There are various explanations that could identify why DNA evidence was a predictor of guilty verdicts; here three reasons will be put forward. First, it is possible that participants attached inappropriate or undue weight to the DNA evidence, considering it credible only because it is science; "as if the aura of science automatically confers trustworthiness" (Rudin & Inman, 2002, p. 5). Another reason draws from research suggesting that jurors have difficulty understanding and discerning the significance of DNA evidence (Dartnall & Goodman-Delahunty, 2006; Findlay, 2008; Goodman-Delahunty & Tait, 2006; Henderson, 2002; Wheate, 2006). It is possible that participants in this study experienced difficulty comprehending the DNA match probability provided, and pre-existing beliefs regarding DNA may have encouraged the guilty verdict. A third reason could be that the probability of the defendant's guilt was determined by or based on the rarity of the DNA match statistic provided in the expert testimony and subsequently the strengths of other evidence was ignored — otherwise known as the "prosecutor's fallacy" (Thompson & Schumann, 1987). This type of fallacious reasoning occurs where jurors (and sometimes lawyers) interpret the random match probability as the probability of the defendant being innocent (Koehler, 2013).

Another area of importance in this study was the examination of participants' knowledge of DNA and its capabilities. Thus, questions were asked attempting to measure participants' knowledge of the individuating capacity of DNA evidence as well as knowledge of biological evidence. More than three-quarters of participants expressed knowledge in response to two of the three questions regarding the individuating capacity of DNA evidence such as the question asking whether gender can be determined through DNA analysis. Likewise, the majority of participants expressed knowledge in two out of three questions pertaining to biological evidence such as the capacity of human hair without the root to be analyzed for purposes of obtaining a DNA profile. Overall, participants displayed a positive appraisal of the capabilities of DNA and the majority agreed that DNA evidence has the capacity to determine guilt, but by itself is insufficient to acquit or convict.

VI. Future Research

The potential explanations for where participants acquire their knowledge of DNA and its capabilities present avenues for future study. Research could aim to examine the main sources of knowledge of DNA evidence for participants and how a given source influences the accuracy of an individual's understanding of DNA. Further studies could examine whether instructing juries prior to their participation in a criminal trial has a positive effect on the accuracy of jurors' understanding of the workings of DNA evidence (Goodman, 1993). Such research could have significant implications for trial practices, especially in regard to decreasing the potential for miscarriages of justice.

The results of the present study have a number of implications for the presentation of DNA evidence to juries in criminal trials (Redmayne, 2001). The use of single-target versus multi-target frames in particular was demonstrated to have notable influence on jurors' perceptions of a defense case, and these findings indicate a need to assess which of these frames is appropriate when presenting DNA evidence to lay audiences. Areas of focus might include whether either the single- or multi-target frame should be used for all criminal trials or whether the appropriateness of each approach should be assessed on an individual, case-by-case basis.

The current study also supports prior research by Ligertwood (2011) and Wheate (2010) in that jurors involved were substantially more likely to return a guilty verdict if DNA evidence was present in a trial. The implications of such findings underscore the importance jurors place on DNA and by extension beg the question of whether criminal justice participants can convict a defendant based on this type of evidence alone. Such issues have serious ethical and legal ramifications that criminal justice personnel are currently debating. The results of the present study corroborate prior research and draw attention to the need for clarification as to whether a defendant must be acquitted if DNA is the only evidence against them (see *Aytugrul v The Queen* [2012] HCA 15, 18 April 2012).

A final implication is in regard to how prosecutors and forensic experts should present DNA evidence to juries. Presenting DNA evidence in either a probabilistic manner as opposed to using a frequency approach had a significant impact on the percentage of jurors who returned guilty verdicts. These effects were most notable for Scenario 4, (multi-target, frequency format), and Scenario 3 (multi-target, probability format), where the number of jurors returning a guilty verdict was more than doubled when the DNA statistical evidence was presented in a probabilistic format rather than a frequency format. As with the single- and multi-target format question, the possibility of adopting a universal approach to either probabilistic or frequency-based styles of presenting DNA evidence is still a matter of consideration. The findings presented here provide additional contributions to the current deliberations about the ways in which such evidence can be delivered to jurors in order to minimise the potential for miscarriages of justice.

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